A FULLY INTEGRATED IN-SITU SOLUTION FOR MATERIALS TESTING IN SEM

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In-situ material testing in SEM is an emerging trend among SEM applications, since it is the powerful method to link mechanical properties to the microstructures of materials, such as grain sizes and orientations, types of grain boundary, defects, inclusions or impurities in grains or in grain boundaries. To understand the connection between microstructures and mechanical properties helps to design novel advanced materials in a most effective way. However, the integration of in-situ testing accessories into an SEM up to now is far from seamless and user friendly. The output is, on the other hand, very sobering in terms of scale of sample area interested, throughput and reproducibility of datasets. For example, to validate and refine the computational materials model a large amount of highly resolved strain mapping at precise mechanical loadings and temperatures of testing samples is required which is, however, hardly available using the in-situ solutions at present. Another example is to approach EBSD analysis in order to reveal grain misorientations and defects caused by mechanical loading. There is, however, no real one-button-start automated workflow for such long term demanding experiments. To address these shortcomings, a well-integrated solution for demanding in-situ testing, combining high resolution surface sensitive SEM imaging with mechanical testing stage and EDS/EBSD analytical methods is currently developed. In this presentation, the solution which enables tailored in-situ automated workflows based on Python scripting is introduced. The automated workflow can generate meaningful data with highest reproducibility and precision. On the other hand, such automated workflows make high throughput data acquisition at high image resolution and precise loading parameters in SEM possible. The high quality of the acquired datasets facilitates post processing and data analysis, for e.g. high resolution strain mapping by means of digital imaging correlation (DIC). Further advancements such as automated feature tracking, and autofocus help to realize true one-button-start workflows and experiments. Results such as grain boundary transition or grain deformation imaged using backscattered electron detector (BSD) will be shown. Examples of measuring grain misorientation during mechanical loading by means of high resolution EBSD as well as high resolution strain mapping using DIC will be discussed.

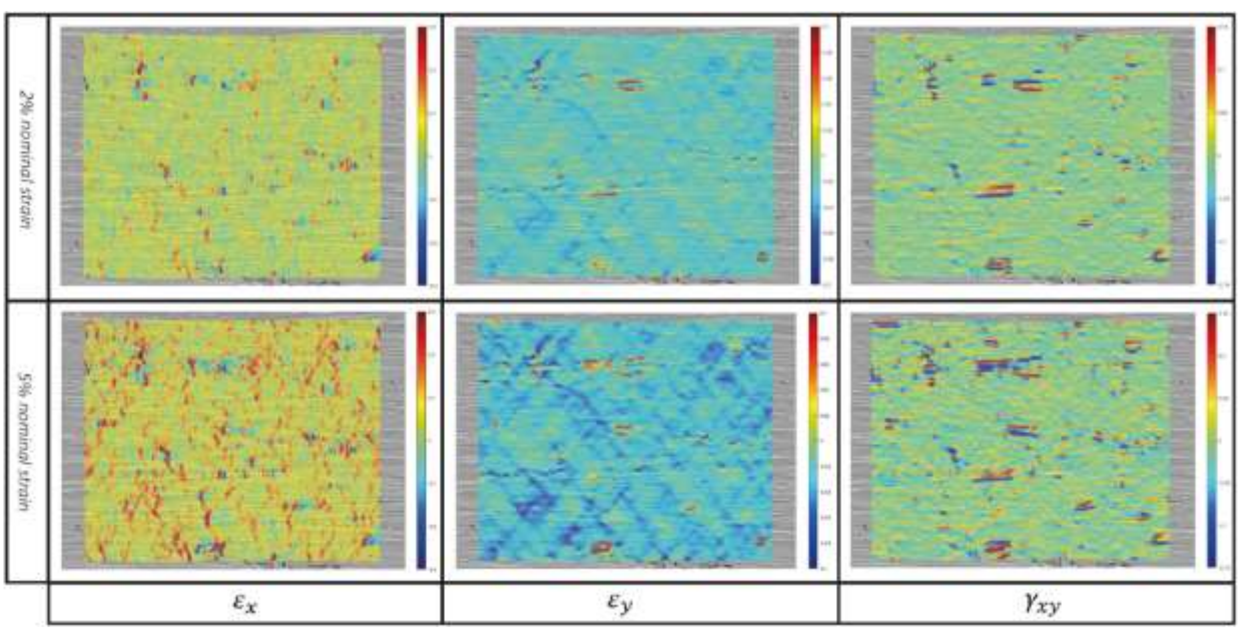

Figure 1 – Local strain distributions of Cu surface at different elongations during the in-situ tensile testing are analyzed by means of digital image correlation (DIC).